the research laboratories of the American Telephone & Telegraph Company and the Western Electric Company, has accepted the position of head of the physics department at Union College and will cooperate with the research laboratories of the General Electric Company in certain research work.

Professor James T. Rood, of the University of Illinois, has been appointed professor of electrical engineering at the University of Wisconsin. Professor Rood was graduated from the Worcester Polytechnic Institute in 1898 and obtained the degree of doctor of philosophy at Clark Institute in 1906. He taught nine years at Lafayette College and has since been two years on the Illinois faculty.

Fred C. Werkenthin, associate professor of botany in New Hampshire College, has been elected to an instructorship in botany in Iowa State College.

Dr. G. R. Bisby, formerly of the University of Minnesota, has accepted the position of professor of plant pathology at the Manitoba Agricultural College, Winnipeg, Canada.

Professor J. T. Wilson has been elected dean of the faculty of medicine in the University of Sydney in succession to the late Sir Thomas Anderson Stuart.

## DISCUSSION AND CORRESPONDENCE

### METHODS USED IN THE STUDY OF SOIL ALKALI

In Science of February 6, 1920, Mr. F. B. Headley, of Fallon, Nevada, took occasion to call attention to imperfections in methods of studying soil alkali used by the Utah Station and some other institutions. His criticism seems to center around two ideas: (1) that we consider that salts added to the soil represent the true concentration of the soil solution; (2) that we did not analyze soils to which salts had been added and that we were therefore entirely ignorant of the amount of alkali the soil contained.

Answering these in order, I may say that in Utah we have never considered salts added to the soil to be anything but *salts added.* Workers in soil science are fully aware of the fact that when such salts as carbonates are added to the soil they immediately undergo transformations that are not well understood. No one, so far as I know, would undertake to tell just what the soil solution as it affects plants really is. It is somewhat like trying to tell the composition of living protoplasm. As soon as an attempt is made to analyze the protoplasm, it is killed and its composition is probably changed. Numerous methods for arriving at the concentration of the soil solution have been suggested. These include (1) direct chemical analysis of leachings of the soil, (2) subjecting the soil to high centrifugal force in an attempt to throw off some of the real soil solution, (3) placing the moist soil under very heavy pressure to press out some of the solution, (4) attempting to obtain the osmotic pressure of the soil, (5) obtaining the conductivity of the soil to a current of electricity, (6) determining the concentration of salts by the lowering of the freezing point, and (7) getting the vapor pressure of the soil in order to determine the concentration of the soil solution.

None of these methods has been entirely satisfactory, but each one has been useful in connection with certain studies. I think it can be said therefore that at present we have no means of measuring the exact concentration of the soil solution as it affects plants. Neither the amount of salt added to the soil nor the amount recovered by chemical analyses represents the true value, and in making any interpretation it is necessary to state specifically in each case whether reference is made to "salts added" or "salts extracted." At the Utah Station we have been very careful to say which of these we referred to in every case.

In a recent publication (Utah Station Bulletin No. 170) we have taken occasion to show the relation of "salts added" to "salts recovered" by extraction using various quantities of water and stirring for different lengths of time, by the freezing point method,

and by the conductivity method. It is evident from these results that in discussing the toxic limits of alkali it will be necessary to state the method used, the same as in discussing the amount of phosphoric acid in the soil it is necessary to say whether the soil was extracted with weak citric acid, weak hydrochloric acid, or fused. The result will vary with the method of extraction.

Mr. Headley mentions several times that we have made no analyses and consequently we do not know what the soil contains. As a matter of fact, we have made thousands of analyses of soils after adding salts to them as well as soils direct from the field. In one of the papers mentioned by him[1] we have given four tables aggregating about 650 determinations to show the relation of "salts added" to "salts recovered" by extraction and as determined by depression of the freezing point.

In Utah Station Bulletin No. 170 we have given the following table:

TABLE I

*Percentages of Salt Added to Soils Determined by Water Extraction*

| NaCl Added (p.p.m.) | No. of Samples | Mean Per Cent. Extracted | Prob. Error in Per Cent of Mean | $Na_2CO_3$ Added (p.p.m.) | No. of Samples | Mean Per Cent. Extracted | Prob. Error in Per Cent. of Mean | $Na_2SO_4$ Added (p.p.m.) | No. of of Samples | Mean Per Cent. Extracted | Prob. Error in Per Cent. of Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (p.p.m.) | | | 15 | (p.p.m.) | | | | (p-p.m.) | |
| None | 15 | (196.3) | 21 | None | 15 | (727.8) | 35 | None | 15 | (454.4) | 36 |
| 200 | 15 | 193.7 | 44 | 500 | 15 | 169.8 | 29 | 500 | 15 | 172.9 | 20 |
| 400 | 15 | 123.0 | 13 | 1000 | 15 | 95.9 | 25 | 1000 | 14 | 141.8 | 23 |
| 600 | 15 | 109.4 | 11 | 2000 | 15 | 58.5 | 19 | 2000 | 15 | 123.7 | 16 |
| 800 | 15 | 107.2 | 8 | 3000 | 15 | 57.0 | 15 | 3000 | 15 | 119.3 | 12 |
| 1000 | 15 | 108.2 | 12 | 4000 | 15 | 51.7 | 10 | 4000 | 15 | 115.0 | 14 |
| 1500 | 15 | 102.9 | 10 | 5000 | 15 | 51.1 | 15 | 5000 | 15 | 111.4 | 16 |
| 2000 | 15 | 102.7 | 8 | 6000 | 15 | 50.4 | 36 | 6000 | 15 | 113.3 | 13 |
| 2500 | 15 | 104.3 | 12 | 7000 | 15 | 48.5 | 17 | 7000 | 15 | 115.7 | 12 |
| 3000 | 15 | 99.8 | 5 | 8000 | 15 | 49.3 | 38 | 8000 | 15 | 119.5 | 16 |
| 3500 | 15 | 97.1 | 6 | 9000 | 15 | 50.3 | 14 | 9000 | 15 | 111.0 | 13 |
| 4000 | 15 | 95.3 | 8 | 10000 | 15 | 49.1 | 13 | 10000 | 15 | 108.1 | 11 |
| Average | | 113.0 | 13 | | | 66.5 | 21 | | | 122.9 | 18 |

This table shows that practically all of the chlorids and sulfates added could be recovered by leaching. In the lower concentrations additional salts, which were originally present in the soil, were recovered. In the case of the sulfates very much more was recovered than was added. This came largely from calcium sulfate which was present in the soil and which was leached out by the comparatively large quantities of water used in extracting the soil. In the soil itself the calcium sulfate is not sufficiently soluble to cause injury to plants; hence, it should be subtracted from the total sulfates obtained. In the case of the sulfates the "salts added" are doubtless a more reliable index to the real concentration of the soil solution than the "salts recovered."

With the carbonates it will be seen that only a part of the salts added could be recovered by extraction. This means that in the case of carbonates a correction factor must be used for the "salts added," although this in many cases is probably just as satisfactory as to use "salts recovered."

Even though we have in all our work had available data on "salts recovered," we have in many cases preferred to indicate the concentration by "salts added," since the former method of expression is open to some rather serious objections which it is probably unnecessary to point out here.

We hope that this will clear up any misunderstanding of our work, for we believe that while "salts added" does not tell the

[1] *Journal Agricultural Research*, Vol. 15, pp. 287–319.

whole story, still it is a very convenient and useful way of indicating the alkali condition of the treatment that is under investigation.

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## THE RÔLE OF PSYCHOLOGICAL FACTORS IN DIGESTION

An experimental report on the relative digestibility of palatable and unpalatable food in a recent number of Science by Messrs. Holder, Smith and Hawk,[1] raises the important problem of the place of the mental factors in such activities of the human being as the partaking of food. In a general way this is the problem of the unified and complete versus the partial functioning of the organism. Now the title of the report in question, namely, "Is Unpalatable Food Properly Digested," clearly indicates that the question of the partial or incomplete functioning of the organism is in point here. For the question of palatableness is one which concerns not merely the comparatively simple, metabolic chemical reaction, but always involves a highly integrated conscious organism such as a human individual.

When we study isolated phases of an organism rather than observe the responses of the organism as a whole, we naturally arrive at different results, and so the report based upon isolated physiological data reads as follows: "If the stomach and intestine can be cajoled into making the proper effort, the unsavory concoction can be digested just about as satisfactorily as can the food mixture which makes a stronger appeal." This conclusion is reached by the observation that there is only one per cent. difference in the utilization of nitrogen when taking palatable and unpalatable food.

At this point appear some questions of extreme importance. For example, has there been sufficient time in the two days in which the unpalatable food has been adminstered for any change to take place in the functioning of the organism? Would not a protracted period of subjection to unpalatable food conditions show marked metabolic deterioration? It is decidedly an open question how long the stomach and intestine can be cajoled into making the proper effort for digestion when the organism (person) perceives and objects to the disagreeableness of the food. Indeed the writers declare that this experiment "shows how insulting we can be to the normal stomach and get away with it, but this does not necessarily prove this to be the wisest policy." Why should there be any question of policy? The answer is clear; the student of psychopathology knows full well what are the dangers of being compelled to respond to food or other situations under unfavorable circumstances. The record of broken-down organisms with incapacitating digestive symptoms is too large to leave any room for doubt as to what hygienic policy should prevail with respect to the palatableness as well as other conditions of the food-taking responses. Further, aside from the too brief period employed in the experiment, one must not lose sight of the fact that the subject was fully cognizant of responding to an experimental situation, a fact which greatly influences the stimulus-response complex.

When we consider the digestive functions as isolated activities of the organism it is beyond dispute that the absorption and utilization of the materials will depend essentially upon the chemical constitution or the food value of the materials eaten, but can we so consider human digestion? To consider digestion or any other organic process as an abstract activity is to overlook entirely the unitary character of a biological organism. Of course, no one can possibly fail to observe the value of the hypothesis that the complex activities of organisms are rather simple chemical reactions, for upon no other basis could progress be made in the investigation of such phenomena. But, this in no wise implies that in order really to understand the organism we must overlook the functioning of it as a whole. And when we do study the organism as a unit we not only find that "psychic stimuli" promote or retard the secretion of

[1] LI., p. 299.